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ABSTRACT

The monograph updates the original 1962 publication and, like it, bases its recommendations for typewriting instruction on what the author considers to be reputable research evidence of two kinds: classroom and other investigations directly concerned with typewriting; and fundamental principles for the acquisition of skill arising from the findings of the experimental psychology of learning over three-quarters of a century. A general statement on teaching typewriting is followed by sections covering: how stroking skill is acquired; developing stroking technique; learning the keyboard; developing stroking skill; media and other teacher-free devices and programs; a miscellany of other instructional considerations; the role of stroking skill in production typing skill, development of production skills; and performance standards and proficiency testing. The monograph concludes with an afterword and references. (Author/NH)

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DELTA PI EPSILON RESEARCH BULLETIN NO. 4

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Implications of Research for TEACHING TYPEWRITING

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Second Edition
1974

Leonard J. West

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Preface

Implications of Research for Teaching Typewriting, published in 1962, was an outstanding contribution to Business Education; in non-technical terms, the author, Leonard J. West, reported his interpretations and recommendations of reputable research evidence dealing with typewriting instruction and the psychology of skill learning. The original publication has been a most helpful and useful resource for teachers of typewriting; for Delta Pi Epsilon the publication has been a source of considerable pride in helping the Fraternity to fulfill its goals of encouraging quality research and of recognizing and utilizing the results of quality research.

Delta Pi Epsilon Research Bulletin No. 4 is an updated revision of the 1962 publication; the revision should be especially useful at this time. Because of the numerous options available to today's teachers of typewriting, it is imperative that they have the ability to capitalize upon the findings of research in fashioning their instructional procedures. Not only should teachers of typewriting find this publication a valuable reference, but it has particular merit for use in graduate and undergraduate methods courses.

The author's contributions to Delta Pi Epsilon and to Business Education have been and are substantial. For his time and talent in making this revision of the original publication, the National Executive Board of Delta Pi Epsilon extends this note of thanks and appreciation.

Gordon F. Culver
National President, 1974-75
Delta Pi Epsilon

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AUTHOR'S NOTE

This monograph updates the original, 1962, publication and, like it, bases its recommendations for typewriting instruction on what the author considers to be reputable research evidence of two kinds: (1) classroom and other investigations directly concerned with typewriting and (2) fundamental principles for the acquisition of skill arising from the findings of the experimental psychology of learning over three-quarters of a century.

No publication as brief as this one can pretend to cover all the issues and the research on those issues. Instead, the focus is on investigations that have a direct bearing on the methods and materials of instruction, further confined to the more important issues. Details judged to be of peripheral or of narrow, rather than general, applicability are unmentioned.

Hundreds of research reports, from the earliest years through 1973, support this monograph. Specifically, the pertinent research through the mid-1960's is represented by the 276 references in the author's *Acquisition of Typewriting Skills* (1969a)—hereinafter, ATS—which treats the conduct of instruction in typewriting in great detail, beyond the scope of this brief monograph. The investigations referenced therein cover a span of nearly three-quarters of a century and undergird most of the contents of this monograph. The later studies, also covered in this monograph, are confined to published reports and to doctoral theses up through those abstracted in the March, 1974, issue of *Dissertation Abstracts*, excluding work at the master's degree level. These later investigations largely confirm earlier typewriting research or verify earlier predictions for typewriting that were based on fundamental principles for learning.

To save dozens of pages in this monograph, only studies not specified in ATS are cited in the References here. For the hundreds of earlier studies that also support the present recommendations, the reader is referred to the particular pages or chapters in ATS.

Examination of the research in typewriting reveals that the investigators' reports range from a wealth of detail on research procedures to little more than a few descriptive phrases, from clearly justified conclusions and recommendations to ones that are insufficiently supported by, or even irrelevant to, the data. This monograph relies almost entirely on clearly justified findings resting on adequately detailed reporting and, crucially, on findings that have been substantiated in other studies. On a few important issues the findings of various studies disagree—almost always because of apparent or suspected differences in procedural details. Occasionally, the investigators' claims are based on questionable research procedures. In this monograph findings and recommendations are given with the degree of firmness judged to be appropriate to the quality of the available evidence.

The intent of this monograph is to increase the basing of instructional practices for typewriting on reputable objective evidence in place of reliance on folklore, mere opinion, and unexamined traditional practices. In that connection the remark made by the late President John F. Kennedy in his commencement address at Yale University in 1962 should be taken to heart:

> *For the great enemy of the truth is very often not the lie—deliberate, contrived and dishonest—but the myth, persistent, persuasive and unrealistic. Too often we hold fast to the clichés of our forebears. We subject all facts to a prefabricated set of interpretations. We enjoy the comfort of opinion without the discomfort of thought.*

Leonard J. West
June 1974 Baruch College, The City University of New York

TEACHING TYPEWRITING

Typewriting is writing by machine. Legible adult longhand is written at a rate of about 100 letters a minute (ATS, p. 10).[1] Ordinary typing rates are about two to three times that fast and range up to more than seven times as fast as ordinary longhand. Add to the feature of speed the perfect uniformity and therefore the perfect legibility of typescript and it easy to see why the typewriter has become the world's primary means of making written records.

The data on employment, typewriter usage, domestic typewriter sales, and enrollment in typing classes demonstrate the enormous use of the typewriter and the substantial market for typing skill. As of March 1974, according to the Bureau of Labor Statistics (1974, p. 33), there were 4.25 million employed secretaries, stenographers, and typists in the United States, comprising 5.0 percent of all employed persons and 28.4 percent of all employed clerical workers. The 15.0 million "clerical and kindred" workers in turn accounted for 17.6 percent of all employed persons, including many other than typists who use the typewriter at least part of the time. Further increases in clerical workers have been predicted for the 1980's (Rosenthal, 1973, p. 19). Finally, 85 percent of all positions open to high school graduates that required any skill required typing skill (Cook and Lanham, 1966).

An estimate made in 1966 (ATS, p. 6) that 35 million Americans use the typewriter (7 of every 25 Americans over the age of 14) makes apparent that personal use of the typewriter is substantial, indeed exceeding vocational use. Domestic typewriter sales in 1972 consisted of 2.5 million machines, with portables outselling standard machines in a ratio of nine to five and, among standard machines, electrics outselling manuals in a ratio of five to one (U. S. Dept. of Commerce, 1973). During the 1970's, electric portables have become increasingly popular (Standard and Poor, 1974, p. O 26).

During the school year 1970-71, typewriting enrollments in the public secondary schools (grades 7-12) consisted of 3.0 million students (one-sixth of all enrollments): 1.9 million in first-year classes, .7 million in second-year classes, and .4 million in personal typing classes (Gertler and Barker, 1973). Since personal typing is offered for a half or full year, never longer, more than three-fourths of typing instruction in the high schools of this country is for one year or less. The foregoing counts, however, are as of a point in time, and beginning typewriting is characteristically offered in the ninth or tenth grade. Accordingly, it may be estimated that in recent years about half of all high school graduates have been in a typing class at one time or another during their school attendance.

From beginnings in the 1880's as a specialized skill for narrowly defined occupational use by relatively small numbers of persons, typewriting has become a generally used skill in numerous occupations and for a variety of personal uses as well. Plainly, the typewriter is a basic writing tool. As such, reputable research findings should be brought to bear on the continuous improvement of instruction.

[1] References to ATS, as stated in the author's note, are to the writer's *Acquisition of Typewriting Skills*, listed among the References at the end of this monograph.

How Stroking Skill Is Acquired

Traditional instructional materials and methods for acquiring stroking skill suffer from several misconceptions about the process, both with regard to typewriting itself and the fundamental principles for the acquisition of (any) skill (see ATS, Chaps. 2 and 3 for details). Here, the real facts are briefly summarized.

THE ORDERS OF STROKING HABITS

The acquisition of typing skill consists of mastery over a series of stroking habits whose levels or orders are defined by the number of consecutive motions that may be made without conscious attention to each motion in the series. At first, responses are made on a letter-by-letter basis; perception of each letter in the copy is the stimulus for each key stroke.[2] Later, series of motions are combined into little chains in which each motion in the series is largely based on the "feel" of the preceding motion. Kinesthetic cues become prominent. (Kinesthesis is the sensation of movement and position in muscles and joints and should not be confused with the sense of touch; "touch" has practically nothing to do with typewriting.) For example, in typing *the* as a chained response, the kinesthetic cues (sensations of motion) that arise from striking *t* serve as stimuli for striking *h*; the sensations created by striking *h* serve, in turn, as the stimuli for striking *e*. As skill develops there is a shift-over from dependence on external cues (the letters in the copy) to internal ones (muscular sensations). More exactly, as skill develops, the stimuli for stroking change from vocalization, through visual perception of each letter in turn, to an amalgam of visual and response-produced (kinesthetic) cues.

Factors Influencing Chaining. Other things being equal, the amount of practice at given letter sequences will determine which sequences will be chained—and amount of practice is commonly governed by the frequency of the given sequence in the language. But other things are not equal. The chief determinant of what can be chained is the ease of making the particular motions that are involved. Chaining is an inference from stroking speed, and all studies show (ATS, pp. 106-109; Beaumont, 1969) that speed increases with alternate-hand stroking and decreases with one-hand stroking. Thus, *th* is readily typed as a chain not only because of its frequency in such common words as *the, them, their, other, with,* et al., but mainly because the motions are made by the strong fingers of opposite hands. In contrast, the sequence *ed*—although highly common (past tense of regular verbs)—is highly resistant to chaining because the motions involve consecutive strokes by the same finger. *Those motions can be chained which can be brought sufficiently close together in time.* Evident here is one of the fundamental principles for the acquisition of skill: the Law of Contiguity (closeness), requiring minimum time intervals between one motion and the next. Thus, instruction that gives heavy emphasis to stroking accuracy at the expense of stroking speed inhibits developing the chained responses that define the acquisition of increasing skill.

[2] Actually, at the very earliest stages the learner pronounces each letter to himself as he strikes its key; vocalization is the stimulus for stroking. Only later does perception of the letter in the copy trigger the keystroke, without vocalized mediation.

Correctives to Five Common Misconceptions. The acquisition of higher-order stroking habits is a much slower process and the extent of chaining is much more modest than have traditionally been supposed. The established facts are:

1. Even among experts, chains are mostly limited to 2- and 3-letter sequences (occasionally longer), largely confined to the high-frequency sequences that involve alternate-hand motions.

2. Higher-order stroking habits are acquired very slowly. Even the 40-wpm typist performs mainly on a letter-by-letter basis. His superiority over the 10-wpm typist lies almost entirely in greater mastery over low-order, letter-by-letter stroking habits rather than in appreciable use of higher-order, chained responses. Indeed, chaining does not become noticeably prominent until speeds of about 60 wpm, and it becomes substantial at speeds in the mid-80's.

3. Chained stroking responses have no necessary correspondence whatever to linguistic units such as syllable, word, phrase. Correspondence of a response chain to a syllable or a word is an occasional coincidence. Most of the chained sequences consist of letter combinations that do not form syllables or words. Nobody types by phrases, and word-level typing is prominent only among experts and is confined to the very small number of short, common words that happen to involve mostly alternate-hand stroking.

4. Beyond letter-by-letter stroking, all keyboard operation involves an interweaving or mixture of stroking habits. Even experts type difficult sequences stroke by stroke (e.g., p*iazza*); and while chaining is more frequent among experts, their chains are heavily interspersed with single-stroke responses.

5. There is no clear division between the levels or orders of stroking habits. The acquisition of skill is progressively characterized by less and less single stroking and more and more chaining of responses.

The two chief instructional implications of the foregoing account of the acquisition of stroking skill are: (1) Stress on stroking speed, not accuracy, is the necessary condition for the efficient development of the chained responses that define skill; (2) Eliminate inaccurate verbiage about typing "by syllables" or "on the word (or phrase) level." That second recommendation also points to the irrelevance of practice materials consisting of selected syllables or words aimed at higher-order stroking habits. Indeed, the whole question of the vocabulary of practice materials for acquiring stroking skill is considered next.

THE VOCABULARY OF PRACTICE MATERIALS

The common tactic of devoting large amounts of practice to the short and commonly occurring words, as words, contradicts the facts that the elemental unit for higher-order responses is the 2- or 3-letter sequence and that mastery over such sequences (as initial, medial, and final parts of words of varying lengths) defines higher levels of skill. For example, not the word *it* is to be mastered, but the sequence *it* as it may occur in such words as *it*, *it*em, l*it*tle, wa*it*, lim*it*ation, facil*it*ate, et al.

The use from first to last of a wide open vocabulary of ordinary prose will necessarily contain the various sequences in precisely the proportions in which they occur in the language. Moreover, certain sequences that occur

as suffixes in a large number of uncommon words that, taken together, make the sequence a common one (e. g., *ful, ity, ness, ible,* et al.) will then appear in the practice materials. Mainly, the common sequences and words get enormous practice in ordinary, unselected prose exactly because they are highly frequent in the language.

THE ROLE OF REPETITIVE PRACTICE

Intensive repetition of small units of material has been an article of faith from time immemorial in all skills. *Excessive* repetition, however, is known to cause the accumulation of mental and muscular inhibitions, increased errors, the fixing of undesirable responses, and fatigue (ATS, pp. 179-180). Excess is clearly evident in such practices as typing an entire line of a particular word.

That extreme aside, the question for typewriting applies differently to (a) keyboard learning and any stroking-skills practice that is *untimed* and to (b) skill-building practice under *timed* conditions. In the former instance, intensive repetition is represented by the common instruction to "type each line (several) times"; extensive repetition, by the provision of a larger number of different lines to be typed once each. Two facts underlie a prediction of superiority for extensive (nonrepetitive) practice: First, the letter sequences that are the proper focus of attention occur over and again in a wide vocabulary—so that nonrepetitive practice is in fact highly repetitive of those sequences; second, the conditions for maximum positive transfer make it impossible for practice at X to contribute to performance at Y (practice at certain letter combinations to contribute to facility at other letter combinations). Thus, better one trial at each of ten sentences than two trials at each of five sentences or five trials at each of two sentences. That prediction has been verified in one study (covering the first 30 class periods) showing extensive practice to lead to superior accuracy and equally good speeds (see ATS, pp. 180-182), as well as in a second study covering the first semester in which extensive practice resulted in superior speed and accuracy (Mach, 1971). During keyboard learning and any stroking skills practice that is untimed, *extensive practice over a varied body of materials is preferable to intensive practice over a smaller body of materials.*

On the other hand, when practice is timed, the question becomes: Shall one build ever increasing speed (or better accuracy) on the same small body of materials (sentence or brief paragraph) or, instead, provide new materials for each new speed (or accuracy) goal? The necessary answer to that question is partly implicit in the conditions for maximum positive transfer and is, in any event, mandated by the self-evident desirability of individualization of speed and accuracy practice and of practice goals (see "Developing Stroking Skill"): *Upon each student's achievement of a specified goal on particular materials, provide new materials for his next goal.*[3]

[3] An investigation by Lauderdale (1971) resulted in no differences between intensive and extensive timed skill-building practice—but under the questionable extensive-practice condition of moving to new copy on each new trial no matter what the performance on the earlier trial.

Developing Stroking Technique[4]

Ballistic Motions. The muscular action of keystroking, like the movements involved in swinging a tennis racket or golf club or baseball bat, is called *ballistic*. The finger is literally "thrown" at the key and carried through its course by the initial momentum—as in the release of a coiled spring. (The contrast is with "fixed" motions, in which muscular tension is maintained throughout the movement.) Ballistic motions cannot be made slowly; that is, a fast motion equals a ballistic motion equals good keystroking technique. Overemphasis on correctness of typescript at the start tends to lead to hesitant motions, to pressing rather than striking of keys. The obvious way to force a fast individual motion, moreover, is to call for a fast overall stroking rate.

Muscular Tension. Years of psychophysiological research established that there is an optimum (best) amount of muscular tension for carrying out a given movement and that marked deviations from that optimum, in either direction, have adverse effects on the movement. Principally to be avoided is the excessive muscular tension that results from attempts to type as fast as possible, as well as the nonballistic tensions that accompany premature focus on accuracy. Instead, during the very earliest stages of practice the teacher can pace the motions stroke by stroke. Later on, during speed-building practice, the setting of goals only slightly beyond the learner's present rate avoids the excess tensions that accompany all-out rates.

Pacing. To control the stroking rate is to control the muscular tensions. For that reason and because controlling the interval between motions aids the beginner to get set for and organize his motions, the earliest stages of practice benefit from stroke-by-stroke pacing by the teacher. In so doing, dictation of each letter in the copy in a sharp, clipped voice will foster striking instead of pressing motions. Sharp voice makes for sharp strokes or, technically, stimulus intensity governs response intensity. However, stroke-by-stroke pacing should be confined to no more than a fraction of a minute on any given occasion and to the earliest practice at each new key during keyboard learning because: (1) Such pacing is metronomic, and the best typing rhythms are anything but metronomic; and (2) Any given rate will necessarily be too fast or too slow for some members of any class, thus violating the principle of individual differences. Also applicable, here and throughout all of human learning, is the overriding generalization that the vast bulk of all practice should be unguided. For motor skills in particular, "discovery" applies (ATS, pp. 111-112); that is, each individual must discover or fall into (without conscious awareness), during practice at his own rates, the motion patterns that are best for him.

Visual Guidance for Motions. Hesitancy in making motions at all costs should be avoided because a hesitant motion is a bad motion. But hesitancy is exactly what results when full touch typing is insisted on from the start. Watching one's fingers is the indispensable condition for learning to make true ballistic motions and should be encouraged, let alone permitted, during the earliest learning stages. The key point is: True touch typing is possible only when the learner can rely on kinesthetic cues (muscular sensations) as

[4] See ATS (Chaps. 5 and 6) for details.

indices of the correctness of his motions, and dependable muscular feedback is never present at the start of learning any motor skill (see "Sight Typing," below). Because visual typing at the start makes the motions less variable (i.e., more uniform in speed, angle and precision of movement, and muscular tension), dependable muscular sensations develop earlier, sooner leading to full touch typing than under the impossible demand that beginners type by touch from the start.

Learning the Keyboard[5]

Order of Presentation. There is no particular order of presentation of keys that has been shown to be most advantageous (by horizontal rows, by diagonal rows, skip-around). The only requirement is that from the first lesson and continuously thereafter, the keys selected permit the immediate use of dictionary words, phrases, or sentences.

Rate of Presentation. All 26 *alphabet* keys have been successfully "presented" (which does not mean "mastered") in one lesson. At the other extreme, three, four and even more weeks are sometimes devoted to alphabet-key presentation. The long-drawn-out presentations, however, are based on a devastating misconception of the true meaning of keyboard learning. For the 26 letters of the alphabet there are not 26 responses to be learned, but hundreds. Consider, for example, the reaches to the *r*'s of *from, cream, erase, brought.* In each instance the *f* finger travels a different distance at a different angle, varying with the stroke preceding the *r*—similarly for the other letters of the alphabet. To *each* key on the typewriter, there are several different motions to be learned, *not* one per key.[6] The *r* correctly struck in *free* in a very early lesson, but misstruck in *brought* when the *b* key is taught many days or several weeks later, reveals the fallacy of over-extended keyboard presentations. Only the first word of "slow but sure" applies to such presentations.

Although there has been no research on rate of keyboard presentation,[7] the superior strategy is a direct inference from the facts of keyboard reaches illustrated above: "Present" the alphabet keys relatively rapidly and let the ensuing weeks take over their proper objective of having the keyboard "sink in." Roughly estimated: 4-5 days for a good class, 9-10 days for an average group, and not more than about 15 lessons for slow learners may be recommended as sufficient for alphabet-key presentation. (The assumption in the foregoing is of a 40-50 minute lesson.)

Practice Materials. For the first few *seconds* of practice at each new reach there is no objection to nonsense drill of the *frf* variety. However, as a basic medium for teaching the keyboard, nonsense drill has been shown in all the studies of it to be less effective than the immediate use of dictionary words, phrases, and sentences.

[5] See ATS (Chaps. 7-9) for details.

[6] Incidentally, the fingering photographs or sketches in typing textbooks that show all but the finger in use glued to their home row keys are patently wrong. It is, for example, impossible to strike *c* while keeping the *f* finger in place on its key; indeed, all stroking that is not entirely on the home row necessarily and properly pulls the fingers to greater or lesser extent out of perfect guide-key alignment.

[7] Except for a number of old studies of a so-called "whole" method that contrasted all-in-one-lesson using prose materials versus many weeks using nonsense drill, with the former being found superior (ATS, pp. 150-151).

The avoidance of wholesale use of non-sense copy aside, one of two other primary requirements for keyboard learning materials arises from the demonstrated superiority of nonrepetitive over repetitive practice. In all instances, but especially in lengthy presentations (more than nine or ten 40-50 minute lessons), textbooks that provide enough different practice lines to permit nonrepetitive typing throughout the lesson are preferable to those that contain a mere handful of lines to be typed repetitively.

Second—because the letter sequence, not the isolated letter, is the heart of keyboard learning—the best materials deliberately put each new letter in sequence with each previously taught letter that occurs adjacent to it in the language, especially consecutive strokes by the same hand: e.g., *yn* and *ym* in *synonym*, *zs* in *buzzsaw*, *wc* in *...owcase*, to illustrate just a few of the less evident instances. Materials that let the chips (the letter sequences) fall where they may are less efficient. Also, because the beginner types letter by letter, his performance is totally unaffected by differences in word length; the occasional longer and less common words needed to represent some letter sequences do not inhibit the learner's stroking speed in the least. Indeed, because the novice tends to pause between words, his speed on long-word copy (providing fewer opportunities for interword pauses) usually exceeds his speed on short-word copy. Specifically, neither the stroking speed nor the stroking accuracy of beginners is significantly affected by differences in word length (ATS, p. 532; McInturff, 1964).

Other desirable features of keyboard-lesson materials include, for example, review lines at the beginning of each lesson that contain all previously taught keys, as well as end-of-lesson test lines that contain all letters taught to date (so that performance in relation to objectives can be regularly assessed). Merely to illustrate a fine detail that few would be alert to, consider the beginner's tendency to linger on the shift key after using it. Not just any words using capitals are wanted, but ones that force the little finger back into use via the letter after the capital using the shift-key hand (better yet, the shift-key finger): for the left shift, names like *Pat, Jan, Nan*; for the right shift, names like *April, Spud, Don, Eugene*. A general principle for the conduct of instruction is invoked in the foregoing shift-key illustration: Use materials and procedures that *make* the desired event take place or that preclude the occurrence of undesired responses.

KEYBOARD PRACTICE PROCEDURES

There are four major practice conditions for efficient keyboard learning, each resting on a solid foundation of experimental evidence, that may be added to the two described earlier (nonrepetitive practice, teacher pacing of the stroking rate for a fraction of a minute for each newly presented letter). First, however, a persistent misunderstanding should be corrected. Learning consists of associating responses with stimuli, and the responses of keyboard operation are motions, not key locations. Learning the keyboard means learning to make a number of different motions toward *each* key, not learning 26 or 42 or 44 "key locations." Among the several conditions for associative learning, the two that are at the level of *Laws* are (1) Reinforcement and (2) Contiguity (see ATS, Chap. 2). The first requires *immediate knowledge of results*, immediate confirmation or correction of the learner's response. Immediate confirmation of a correct response "reinforces" that

response—makes it more probable the next time the same stimulus occurs; immediate correction of a wrong response reduces the probability of that wrong response recurring. Contiguity refers to closeness in time: between stimulus and response, between one response and the next, and between response and knowledge of whether or not that response was correct. One or both of those two indispensable conditions for learning are invoked in the first three of the four practice procedures described next.

Emphasis on Rapid Stroking. Here, the contiguity condition is self-evident: minimum delay between perceiving the letter in the copy and making the stroking response, minimum delay between one stroke and the next. The consequence of a focus on mere stroking accuracy is at the inevitable price of slowing keyboard learning because such a focus necessarily leads to exactly the delays one wants to avoid—let alone to nonballistic stroking motions, to bad keystroking technique. The best advice to the student is that he type at a good clip, not "make a big thing" out of each stroke, that he type at a rate that feels just a little bit uncomfortably fast. Administration of many brief practice timings during the course of each keyboard lesson is also extremely desirable. Precisely because initial emphasis on speed meets the fundamental requirement for contiguity, the many speed versus accuracy experiments in typewriting confirm the advice given above (see ATS, pp. 283-286).

Early Sight Typing. Insistence on touch typing from the outset is perhaps the most devastating fallacy ever to pervade typewriting instruction—contradicting, as it does, the long-established fact for all motor skills that dependable muscular or kinesthetic feedback is absent among beginners and that the beginner must see what he is doing and what he has done if he is to learn efficiently (ATS, Chap. 4; Singer, 1968).

Premature insistence on touch typing has the following undesirable consequences: (1) It leads to hesitant or nonballistic motions, to pressing instead of striking of keys. (2) It leads to long delays between perceiving the letter in the copy and making the stroking response, thereby violating the requirement for stimulus-response contiguity. (3) It robs the learner of reinforcement; the knowledge of results that comes from visual checking of the copy after an entire line or more has been typed is too late after the stroking to have any effect (immediacy or contiguity between response and knowledge of results is absent). (4) It creates anxiety and emotional tensions in the learner. (5) It leads to very large numbers of errors among those who take the teacher's insistence on nonvisual typing seriously. As proof thereof, when typists ranging in skill from 9 to 108 wpm were literally prevented from seeing the typewriter or their typescript, there was (compared to ordinary typing conditions) a 128 percent increase in errors among 9-14 wpm typists down to a 28 percent increase among 95-108 wpm typists; in addition, when deprived of vision, beginners were aware of only one-fifth of their errors and experts of only half their errors when they had only muscular sensations to rely on (ATS, Chap. 4; or West, 1967 or 1968a).

Such findings make apparent that the millions over the years who have learned to type under the prevailing insistence on touch operation from the outset have learned despite that instruction, not because of it. Beginners

"look" no matter what the teacher says because they cannot learn otherwise.[8] The place for blank keyboards, key caps, and the like, as one authority remarked years ago (Dvorak, et al., 1936), is "the rubbish heap." Wall charts of the keyboard are equally offensive when in view for more than the few seconds it takes to point out a new key location and fingering reach. There is no guidance so perfect as the open keyboard itself; indefinitely long access to keyboard charts merely cripples the learner.

A number of classroom comparisons of early sight typing have been conducted (e.g., most recently, R. Jones, 1973). None of them appears to have gone beyond mere teacher talk to the timely employment of specific instructional procedures for efficient transition from sight to touch typing (as described in ATS, pp. 182-191, or in less detail in West, 1968a). In the early-sight classes, the investigators naively introduced strictures against sight typing for the whole group immediately upon completion of keyboard presentation, instead of coming to grips with individual differences in readiness to move toward nonvisual work.[9] A crucial recognition is that kinesthesis is a sensory mechanism and that kinesthetic sensitivity, like visual and auditory acuity, varies among humans. Thus, learners with high kinesthetic sensitivity will accomplish the transition to touch typing in a week or two, while those with low kinesthetic sensitivity may require several months. In any event, one does not leave the transition to chance and time, but facilitates it by specific instructional procedures aimed at it, principally speed forcing. Also, for all learners the transition is gradual and progressive, not all at once; more and more of the stroking comes to be carried out without visual guidance or confirmation.

Immediate Error Correction. The learner's natural tendency, built up over all his past school and life experience, is to want to correct his mistakes (e.g., in typewriting, by strikeovers). The pertinent finding from psychological research on all sorts of learning tasks is that immediate error correction is an important aid to learning. That is, following an incorrect by the correct response disrupts any possible tendency to establish a wrong response, and it satisfies the learner's natural desire to repair mistakes that he is aware of. Accordingly, during keyboard-learning practice that is untimed, the learner who notices a mistake as soon as he makes it should immediately follow it with the correct stroke or should space once and retype the word (*tghe* or *tg the* or *tge the*). The key requirement is immediacy; errors not immediately sensed or noticed should be ignored. Also, immediate error correction does not call for continual watching of typescript in order to catch errors. Instead, the teacher's suggestion should be a casual one to the effect that if the learner happens to notice or sense a misstroke immediately after it is made, he should follow the procedure described.

Overt, Letter-by-Letter Vocalization. All beginners spell silently as they type, that incipient vocalization (not perception of the letter in the copy) being the real (associative) stimulus for keystroking. The principle that stimulus intensity governs response intensity suggests the merit of

[8] See Wonderling (1971) for a review of the evidence on the formidable difficulties in teaching the blind to type—because they can't see!

[9] Even so, the various studies show either no differences in outcomes or superiority for early sight typing and no tendency for nonvisual work to become habitual.

advising students to spell in the sharpest possible whisper as they type. Making the vocalization overt rather than covert aids keyboard learning, fosters sharp stroking if the vocalization is sharp and clipped, and helps to reduce distraction from the noise of other typewriters and from perception of other letters in the copy resulting from conflict between ordinary reading habits and the letter-by letter reading habits needed for beginning typewriting.

Vocalization, however, is an early crutch and, like all crutches, must be discarded when it is no longer useful and threatens to lock the learner into elementary stroking habits. Speed forcing is one applicable tactic. Another is word-by-word vocalization strictly confined to two- or three-letter words because longer words are beyond all but the expert's ability to execute while pronouncing the word rather than its separate letters.

LEARNING THE NUMBERS AND SYMBOLS

Poor mastery over numbers and symbols is a common complaint, especially the frequency of visual typing of those keys. Except for statistical typists, who presumably comprise only a small proportion of all typists, alphabetic typing greatly exceeds number and symbol typing.[10] Surely, investing time in number/symbol practice sufficient for facility approaching alphabetic skill is unwarranted.

In any event, no specialized tactics for teaching the numbers and symbols have been found to reduce the incidence of visual typing of those keys or to increase skill at them (see ATS, pp. 218-220). More practice at them in the context of realistic production tasks (not artificial drills) may be expected to have the desired effects.

Of possible additional interest: it makes no difference in what order the numbers are presented, whether serially or in random order (E. Jones, 1966); equal outcomes followed teaching the numbers with the alphabet keys as compared to later teaching of the number keys (Johnson, 1971);[11] the numbers in business communications average 3.86 spaces and three-eighths of them include punctuation, comma and decimal point (Grill, 1965).

10 The one study to date (Wise, 1968) that reported number/symbol frequencies in relation to total content of tables, manuscripts, memoranda and business letters collected from metropolitan employers is of uncertain representativeness. It showed that numbers make up one-eighth of the words (37% in the tables and 7%-8% in each of the other three types of items). Symbols, as best as can be inferred, account for an estimated 5%-7% of the *strokes* (80% of them for continuous underscoring – place for signature in letters and rulings in tables – 10% for the hyphen, and all others accounting for the remaining 10%). As a nice example of the differences that tend to occur when different samples of materials are examined, in another study (Larson, see ATS, p. 221) the hyphen accounted for 25% of the symbols.

11 Therefore, and for reasons of efficiency and student motivation, one might well teach first and early the numbers required for the current date, adding each day thereafter whatever one or two new numbers might be required for its date (see ATS, p. 127). A few minutes of daily "date typing" are a thing apart, not in the least precluding later using the textbook's number lessons no matter what numbers each may include.

Developing Stroking Skill [12]

Deliberate programs for building stroking speed and accuracy immediately follow keyboard presentation and are applied periodically through much of the training thereafter. A number of fundamental principles for learning, as well as the highly consistent findings of the many speed vs. accuracy investigations that have been conducted over the years (ATS, pp. 283-294), are pertinent. General considerations, findings about speed, and findings about accuracy are discussed, in turn, as a prelude to characterization of a skill-building program in accord with the available evidence.

SOME GENERAL CONSIDERATIONS

Separate Speed and Accuracy Practice. Easily the central and most compelling principle for building stroking skill arises from the uniform finding (in all of the dozens of investigations over many decades covering thousands of students) of an essentially zero relationship between stroking speed and stroking accuracy: Typists at all levels of speed are found at all levels of accuracy (ATS, p. 238). The mandatory inferences are that speed and accuracy are based on different underlying factors and, for that reason, require separate practice.

Goal Setting. The general finding for any learning task that specific and individualized goal setting is superior to urging the learner to do better or his best or to improve his previous performance (ATS, p. 235) suggests disadvantages to those speed building routines that merely urge faster typing—in contrast to those that specify a particular wpm goal: e.g., of 19 wpm for the 18-wpm typist, of 27 wpm for the 26-wpm typist, and so on. The setting of goals no more than 1-2 wpm above one's previous rate arises from the known adverse effects of excessive muscular tensions, such as those resulting from instructions to type as fast as possible, and from the known superiority of short-term over long-term goals.

To individualized goal setting slightly above one's previous best rate, add adherence to the foremost requirement for all of learning, immediate knowledge of results, and it follows that skill-building materials should be designed and formatted to make immediately apparent to the learner upon completion of any practice trial whether or not he has attained his specific wpm goal.

Individualization of Stroking-Skill Programs. Conventionally, when speed practice is done, all students engage in such practice for whatever number of timings is involved during a given practice session; similarly for accuracy practice. While such tactics might appear to simplify classroom management, their fallacy is apparent in the obvious answers to the questions: Can it be that all students at any given moment are in need of speed practice? or of accuracy practice? No research in the typing classroom is needed to demonstrate what is axiomatic: The ideal is for each student at all times to practice according to his needs—for speed or for accuracy, as the case may be—and to change his practice emphasis from speed to accuracy and the reverse according to his achievement of the goals for the one kind of practice before switching to the other.

12 See ATS (Chaps. 10-12) for details on the pertinent research through the mid-1960's and the resulting inferences for instruction.

Practice Materials. Nothing by way of specialized content, vocabulary, letter sequences or anything else has ever been found to have the slightest positive effects on stroking skills—in contrast to ordinary prose. The rule for skill-building (and all) materials—once past keyboard-presentation stages—is ordinary adult prose on a variety of topics, so as to maximize the breadth of vocabulary and thereby the variety of letter sequences (ATS, pp. 153-163). Stress on a common-word vocabulary has not been shown to have any advantages (ATS, p. 155). Gains on the so-called "speed sentences" found in many textbooks (tending to consist largely of short words involving much alternate-hand stroking) are largely spurious because the transfer can only be to those segments of ordinary prose that happen to consist of the same sequences as in the speed sentences. Transfer of gains to "all copy" requires practice at "all copy" (i.e., at the largest possible variety of letter sequences—the chances of variety being maximized in ordinary prose over a wide vocabulary). The dizzying variety of special accuracy development materials are also useless (see below).

Repetitive vs. Nonrepetitive Practice. The conditions for maximum positive transfer mandate the provision of new copy for each new goal and argue against the building of ever increasing speed or ever increasing accuracy on the same small piece of practice materials (sentence or short paragraph). Indeed, the fundamental structure for skill-building practice should consist of repetitive typing of the same copy until its goal is met, followed by repetitive practice at new copy until its goal is met.

Self-Paced vs. Externally-Paced Practice. Under self-pacing, the learner determines his own stroking rates, whether or not provided with a terminal goal. The alternative, external pacing, has two underlying rationales: (1) the avoidance of excessive (or insufficient) muscular tensions by guiding the learner to type at just the desired rate, neither faster nor slower, and (2) the providing of knowledge of results (Am I typing at the desired speed?) at intervals during the timing, not just at the end.

External pacing is accomplished either by internal marking of the copy at intervals or by devices that display successive portions of the copy at predetermined rates or for predetermined durations or that generate a time signal (a beep) at intervals during the timing. External pacing, by teacher's voice or by various devices, has been investigated, and the outcomes vary with differences in a host of other features—so much so that effective pacing clearly requires the accompaniment of certain features and the avoidance of others, as described later (see "Media and Other Teacher-Free Devices and Programs").

In any event, both self-paced and externally-paced practice is desirable for several reasons. For one thing, there is some (but not consistent) evidence suggesting that some persons have a preferred "personal tempo" applicable to everything they do and are resistant to or incapable of following an imposed rate (ATS, p. 246). If so, they will not benefit from external pacing. For another thing, external pacing is an artificial crutch, absent in real-life typing. On the other hand, the benefits of scrupulously individualized external pacing of responses is undoubted (ATS, p. 306; Lumsdaine and Glaser, 1960, p. 320). Thus, both external pacing for the sake of efficiency in gaining stroking skill and self-paced practice for the sake of transfer of practice gains to ordinary typing conditions may be recommended. Until

such time as some optimum mix of the two kinds of practice may be identified, student preferences and the outcomes of each of the two kinds of practice in any class might serve as a guide to how much of each kind of practice to use.

Duration of Practice Timings. Practice timings as short as twelve seconds to as long as five minutes have been used in the various investigations, the one-minute timing perhaps being most prevalent in typing instruction.[13] The pertinent principle is: Timings so long that the typist cannot maintain the desired rate throughout are too long; those substantially shorter than the typical durations of real-life typing cannot have high transfer. Very likely, then, the duration of practice timings should increase as the training progresses, possibly from about thirty seconds to two or three minutes (under self-paced conditions). Because external pacing provides a guide and a spur to the maintenance of one's stroking rate, it is conceivable that under such pacing timings could profitably extend beyond two or three minutes. Whatever the mode of pacing, the facts about typing fatigue and the conditions for positive transfer show that the conventional clinging to very brief practice timings (fractions of a minute to a minute) for weeks on end before increasing the timing duration is based on myth. Timings of less than 1 minute should probably be confined to not more than about 1 week, and a move from 1- to 2-minute practice timings should perhaps be made by late in the first semester of instruction.

SPEED BUILDING

The principle for speed building is expressible in three words: force the rate. Faster rates result only nominally and at the start from making faster individual motions. Overwhelmingly and throughout instruction and later use of the typewriter, speed gains result from crowding successive motions ever closer in time—from the contiguity conditions that reduce delays between motions and lead to the chaining of responses. Under forcing of the response rate the learner "discovers" or falls into (without conscious awareness) the new and improved patterns of motion that distinguish faster from slower speeds. During such rate forcing, the impossibility of adding to speed while maintaining high accuracy mandates that speed practice be done with no or very generous error limits.[14] Indeed, the student who does not make many errors during speed practice is not typing fast enough to benefit from the practice.[15]

[13] Several recent investigations that purport to show superiority for very brief over longer timings suffer from one or more of various weaknesses that preclude accepting their findings: e.g., confounding of differences in timing lengths with differences in practice materials, impermissible scoring procedures, primitive modes of data analysis, descriptions of procedures so skimpy as to make it impossible to determine exactly what the procedures were.

[14] Numerous investigations covering thousands of students (e.g., ATS, p. 501; Garry, 1967) show that 10 errors is the average throughout first-year typewriting on 5-minute *test* timings oriented toward good overall performance (speed *and* accuracy). Thus, error limits during speed practice of 2-3 errors per minute are absurdly low and self-defeating. Dozens of errors per minute are not excessive; the only necessary safeguard is against wild banging of keys without honest intent to follow the copy.

[15] Because the student's entire past school and life experience has put the premium on minimizing mistakes, the typewriting teacher must explain why acquiring stroking skill requires separate speed and accuracy practice and must assure the student that his accuracy practice will drastically reduce the large numbers of errors made during speed practice (see, e.g., ATS, p. 287).

ACCURACY DEVELOPMENT

Stroking accuracy is among the most heavily investigated areas of typewriting research, and the typing textbooks swarm with so-called accuracy drills—from which one must infer a paralysis of concern with stroking errors among typewriting teachers and textbook authors. That concern—and the concoctions of specially designed accuracy drills that pervade instruction—are irrelevant and immaterial for the following four reasons:

1. Accuracy improvement has nothing to do with the content of the practice materials. The dozens of investigations that, taken together, employed nearly every conceivable type of drill materials showed them to have not the slightest positive effect (ATS, pp. 258-272). Such drills leave unchanged throughout instruction both the number of errors and the rank order of frequency of various types of errors (e.g., Garry, 1967, among many). This is not to say that errors are equally distributed across all *letters*; for studies going back to the 1920's show unequal distributions. A later study purporting to show that errors vary with *letter sequences* permits no such inference.[16] In any event, the implication that letter-sequence drills will improve stroking accuracy (Robinson, 1972; Weaver, 1966) may be dismissed out of hand because just such drills were found totally useless in dozens of earlier studies.

2. The typing eraser (requiring about 30 seconds to make a simple correction) has been disappearing from real-world use in favor of correction strips (Ko-Rec-Type, among many) that accomplish a simple correction in about 5 seconds; for correcting consecutive words and entire lines, there are various fluids (Erickson, 1971). Overconcern with mere stroking errors is misplaced in view of the speed and ease with which they can now be repaired. The employer's requirement is not that the typist make few errors but that he find and correct his mistakes (Erickson, 1971).

3. Individual error counts vary enormously from one occasion to another. Technically stated, error measures have very low reliability (ATS, p. 296). It is indefensible to give great weight to a feature of performance that cannot be reliably assessed.

4. Stroking skills are measured by straight copy timings, and such timings are a wholly artificial school task having no counterparts in the real world except in some employment tests. Once employed, no typist copies from perfect print heedless of errors and free of the production-typing requirement for attractive arrangement of materials on the page. The assumed or hypothesized contribution of stroking skills to production typing skills is a substantial fiction. Relationships between straight copy accuracy and misstrokes in production tasks under conditions of no-error-correction are trivially small (ATS, p. 330), and straight copy misstrokes greatly exceed production misstrokes (ATS, p. 339). The foregoing facts demonstrate that the stroking habits (and the typist's perception) of production typing differ from those of straight copy typing. Concern for a feature of performance that contributes little or nothing to the production skills that are the real objectives of instruction is indefensible.

[16] The design of its materials and its procedures for error scoring were wholly inappropriate to the purposes of the study.

Illustrative Useless Accuracy Procedures. Totally ineffective are:

1. All specialized concoctions of drill materials: one-hand, balanced-hand, double-letter, reach-stroke, ad infinitum.

2. Repetitious practice on the particular words mistyped—even in their phrase or line setting.

3. Error analysis charts or technique check sheets (ATS, pp. 139-141).

4. Rhythm drills, typing to music, or any other stroke-by-stroke pacing involving equal interstroke time intervals. As was shown definitively in the 1920's and early 1930's, the best typing rhythms are *least* metronomic (ATS, pp. 104-111).

5. "Concentration" drills employing unusual or foreign words or jumbles of letters.

6. Use of "perfect copy" as a goal and repetition for the sake of perfect copy.

7. Stringent standards of accuracy early in learning.

Overwhelmingly, the various investigations (ATS, pp. 258-272) show that learners who do neither preventive nor remedial practice associated with particular types of stroking errors perform as well as or better than those subjected to one or another of the procedures listed above.

The True Basis for Stroking Accuracy. The generalization for *all perceptual-motor skills* is that "Accuracy appears to be a function of controlling the response rate" (Lumsdaine and Glaser, 1960, p. 320); and the mere fact that stroking errors increase more and more as stroking speeds more and more exceed one's normal, comfortable rate should have made apparent decades ago that *stroking accuracy depends on typing at the right speed*—the "right speed" very likely being one a little below the rate at which too many errors are made. The mistaken focus on the content of drill copy is a monument to uselessness and one of the tragedies of traditional instruction. The implementation of the true principle governing stroking accuracy is described following a brief list of particular and common student difficulties that do lend themselves to specific treatment.

Useful Specialized Accuracy Procedures. A number of useful procedures are derived partly from fundamental principles for learning and partly from typing research (ATS, pp. 272-279).

1. Enormous numbers of errors during test timings and typescript evidencing crowding and piling of letters, omitted letters and spaces, and the like, are the signs of typing too fast. For such persons, having them revert to stroke-by-stroke vocalization as they type is sometimes an effective remedial procedure. That procedure, however, should be recommended only to the few who need it and should be used sparingly because it brings all stroking back to the most elementary levels.

2. Both for initial teaching of the shift key and at any time among those who exhibit flying capitals and other signs of poorly timed shift key operation, provide sentences loaded with capital letters; e.g., *Tom, Dick, and Harry came to New York from Iowa in May.*

3. For incorrect spacing around punctuation marks, provide materials loaded with such marks: for the comma, sentences such as *Fred, Tom, and I visited London, Paris, Rome, and Madrid;* for two-space spacing between sentences, several short sentences on one line, as in *He came. I left. They waited. Call him. Be pleasant.*

4. The substitution error (mainly consisting of striking a key nearby to the desired key) accounts for the overwhelming proportion of all stroking errors and—curiously—has never been attacked via materials based on the underlying cause of such errors: the very small differences in motion toward a given key and its immediate neighbors. The applicable materials give the student practice at making the fine distinctions between motions by jamming together the commonly substituted letters. Thus, for *r-t* confusion: *Try to rotate the tires at intervals*; for *m-n* confusion: *Maintain a nominal account in Denman's name.* Supply a number of such sentences and/or lines of words for each of the high-frequency substitution errors and use them as drill materials immediately following keyboard presentation and from time to time thereafter.[17]

5. The use of ordinary prose over a wide vocabulary will tend to include the various letter sequences. To insure full coverage, however, occasional practice might be done at lines of words that deliberately include all of them from *aa* through *zz*, as in: ba*zaar*, la*b*el, . . . anal*yz*e, fu*zz*y.

The principle applicable to items 2-4, above, is evident and easily stated: Whatever the objective, provide the learner with very many opportunities to make the desired response, not a mere handful of scattered, accidental opportunities. Number 4 rests, in addition, on the long established merits of discrimination or differentiation training for the highly confusable elements in any learning task.

A RECOMMENDED STROKING-SKILLS PROGRAM[18]

Bringing together the various principles and research findings discussed in the preceding pages, the superordinate concept for building stroking skills is this: *Build more speed than you can control; then release only such speed as you can control.* The chief accompaniment of that principle—and chief distinction with the lockstep procedures of traditional instruction—is total individualization of all practice: of practice goals and of practice emphasis (speed or accuracy).[19]

Speed Practice. The practice objective is: *Achieve the goal speed, regardless of errors.* Repeat the same copy in timing after timing until you do so; when you do so, move to new copy at the next higher wpm speed. Illustratively, the student who succeeds at 20 wpm on practice materials X next attempts 21 wpm on practice materials Y.

Change from Speed to Accuracy Practice. The preponderance of the evidence favors substantial, rather than trivial, speed increases before

17 See ATS, p. 218, for a rank order of substitution errors among typists and p. 278 for additional, illustrative "response differentiation" materials.

18 *None* of the commercially published typewriting textbooks as of 1974 encompasses in its skill-building program all of the principles and particular research findings applicable to both materials and procedures. Nor has any typewriting research to date contrasted the outcomes from such a program in relation to alternatives. The program recommended here is a straightforward derivation from the currently available evidence.

19 For convenience of classroom management it is recommended that the *first* skill-building session begin with speed practice for all—each student beginning with a goal (and practice materials marked therefor) 1-2 wpm above his gross speed when typing at a comfortable rate (as measured on a brief timing just preceding the skill-building practice).

changing to accuracy practice (ATS, pp. 288-291). Specifically, since first-semester typists average about 5 wpm faster when typing "all out for speed" as compared to typing at a normal rate (ATS, p. 254), achieving an increase of about 5 or 6 wpm over one's previous best rate may be recommended as the criterion for changing to accuracy practice. Thus, the student whose normal gross rate is 19 wpm practices for speed only from 20 to 24 wpm (1 wpm at a time) and then changes to accuracy practice.

Accuracy Practice. With stroking accuracy dependent on typing at the right speed and the right speed being one a little below the forced speeds (and high error rates) of speed practice, the student drops back 2 wpm (e.g., from his highest speed-practice rate of 24 wpm to 22 wpm—using the same materials as in the immediately preceding speed practice) and practices toward the dual criteria: *Type at the desired rate with no more than 2 errors per minute* (see Footnote 14). Accuracy practice continues until success at one's previous highest speed (e.g., progressively at 22, 23, 24 wpm). Again, as many trials as the student may need at 22 wpm are involved before he moves to 23 wpm and then from 23 to 24 wpm.

Change from Accuracy to Speed Practice. When the student has met the dual goal of typing at his previous highest speed with no more than 2 errors per minute, he returns to speed practice toward another 5-wpm gain (1-2 wpm at a time).

The Practice Cycle. "Up 5, down 2" expresses the practice cycle. Illustratively for the typist whose normal test rate at the outset is 19 wpm: for speed from 20-24 wpm, then for accuracy from 22-24 wpm, then for speed from 25-29 wpm, then for accuracy from 27-29 wpm, and so on, cyclically. Following the first skill-building session (see Footnote 19), each student thereafter practices for speed or for accuracy and changes from one emphasis to the other according to his own performance during the skill-building program. Of two students sitting side by side, one could be doing speed practice at 23 wpm; the other, accuracy practice at 31 wpm.

The recommended program has two necessary accompaniments. (1) Because each student begins each practice session where he left off the time before, he needs to maintain a simple record that shows him whether to practice for speed or for accuracy and at what speed. (2) The practice copy must either be marked internally for the various wpm speeds or cut to lengths exactly equivalent to each wpm speed—the latter easily being the preferable option because it supplies new copy at each new speed.[20] Finally, upon each change to a longer timing duration (e.g., from 30 seconds to 1 minute to 2 minutes, etc.), each student should begin with speed practice based on his gross speed when typing at a normal rate (see Footnote 19), as measured anew upon each change to a longer timing duration. Increase in the duration of practice timings should be progressive, without backtracking; e.g., after beginning 2-minute timings, do not regress to 1-minute timings.

[20] To the extent that fundamental principles for learning and the evidence from typewriting research are properly implemented in the recommended program, such modifications as later research might suggest should be expected to be in minor details, not in basic structure or underlying rationale.

Media and Other Teacher-Free Devices and Programs

Both instrumentation of portions of typewriting instruction and self-instructional printed materials (i.e., programmed instruction) appeared upon the scene in the mid-1950's. At first, the various devices were applied to building stroking speed and accuracy, all of them being, in essence, pacing devices for assisting the student to type at a specified rate.[21] More recently, instrumentation has been applied to initial keyboard learning as well, again with self- or external pacing as a key feature,[22] sometimes accompanied by immediate knowledge of results for correct stroking. Then there are "multi-media" programs involving mixtures of hardware and printed materials,[23] as well as printed "programmed instruction" accompanied by ordinary typewriters, without special hardware.[24] The present discussion of course does not reflect manufacturers' hardware/software modifications during the period since the investigations cited here.

Some of the hardware is accompanied by software; for others, the user supplies his own software (practice materials). Some devices are for group instruction; others are individualized. Some pace stroke by stroke, metronomically; others pace over larger units of material or time spans. The latter tactic is also represented in ordinary printed materials marked internally for pacing, without accompanying special hardware (Rhodes, 1974: West, 1968d). The key feature of most of the hardware systems, whether for group or individualized practice, is tireless, high-precision external pacing of the response rate via control over the stimulus display rate (the practice materials)—which may be taken as sufficient testimony to pacing as a major condition of practice. Equipping a classroom with a device for each student is nearly always more expensive than using some other group device. Some of the group devices, however, are expensive enough, and one must avoid the temptation to employ such devices—especially stroke-by-stroke devices—beyond the period of their genuine usefulness merely to justify their dollar costs.

The various investigations of the effects on proficiency of these devices in contrast to traditional (entirely live) instruction and to each other have had varying outcomes. The general tenor of those outcomes (see Dupras, 1973, for a good review of details) handsomely verifies the general principles and the particular research findings discussed earlier in this monograph. For one thing, the large individual differences in proficiency evident within minutes after instruction has begun demonstrate the advantage of individual over group devices. No group device can at all times pace at just the right rate for all students. Second and equally important, stroke-by-stroke pacing

[21] Examples are the tachistoscope and the Skill-Builder Controlled Reader (see Perkins, 1964, or Dupras, 1973, for a review of the evidence on them; also ATS, pp. 306-316, for a discussion of the rationale underlying pacing), the Strong Pacer (see ATS, p. 310), the SRA Mark III Reading Accelerator (McAnally, 1966), and an essentially diagnostic device, the Diatype (Shell, 1966).

[22] Examples are the Gregg/Pacesetter (Trexler, 1973), the Kee and the "Mind" systems (Showell, 1972), the electronic wallchart (viz., Kee) (Guyot, 1973), and the "Automated Instruction Touch-Typing System" (Dupras, 1973).

[23] See, e.g., reports by Frye (1972) and Thoreson (1971).

[24] Some examples are Varnon (1973) and West (1970, 1971)—both devoted to production typing—and Kline (1971) for copying skills.

imposed for more than fractions of a minute at a time, entirely confined to the very earliest stages of practice, violently contradicts the true rhythms of typewriting (the best ones being *least* metronomic). Accordingly, such devices (typically employed far past their period of usefulness, probably to justify their dollar costs) have failed to show advantages.

The hardware, as hardware, carries out a pacing function (and sometimes a knowledge-of-results function) more tirelessly and reliably than the teacher can. But the software and the surrounding instructional conditions are more important than the hardware. Outcomes vary with the kind of pacing (stroke-by-stroke or in larger units), with the practice copy (prose or artificial drills), with the duration of paced timings, with the distribution and amounts of speed and accuracy practice (whether self- or externally paced), with the practice standards (a requirement for perfect or near-perfect accuracy during accuracy practice having been found disadvantageous), with the extent to which the practice is individualized, and so on.

A major, large-scale instance that points to what really counts is an investigation among Army typing trainees (Showell, 1972) that compared a number of automated devices and programs of the time (Kee, "Mind" and several automated Army programs) with conventional Army instruction and with materials and procedures for building stroking skills derived by Showell from this writer's *Acquisition of Typewriting Skills* (West, 1969a). Of two such derivations, the one more closely resembling this writer's intent for skill building ("free pace, forced pace") ranked first in merit among the ten instructional systems that were compared. Its leading features were: individualized rate forcing, individualized goal setting, individualized distribution of speed and accuracy practice, reasonable (2 epm) error limits during accuracy practice, and ordinary prose materials—no artificial drills. The investigator also made a compelling reference (p. 52) to the boredom characteristic of typing practice and to the superior motivation that results from any system employing explicit and progressively advancing proficiency goals, a race against the clock to meet those goals, immediate knowledge of results, and a visible record of one's progress.

Indeed, everything known about skill acquisition processes demonstrates that nearly everything students do at the typewriter should be against a running stop watch or the equivalent thereof. Add to that: total individualization of practice (on realistic materials toward sensible goals), accuracy practice based on reducing one's speed, and immediate knowledge of results—and you have a capsule summary of what the acquisition of stroking skill is all about.

A Miscellany of Other Instructional Considerations

Considered here are: (1) Personal and vocational objectives, (2) Incidental vs. intentional learning, plus other features of instructional materials and objectives, (3) Training for electric and manual typewriters, (4) Proofreading and error counting, (5) Class size and other scheduling arrangements, (6) A common difficulty in acquiring skill, (7) Motivational variables, and (8) Selection of trainees.

Personal and Vocational Typewriting. Featheringham (see ATS, pp. 325-327) surveyed the post-instruction typing activities of those formerly

enrolled in personal typing courses. Those activities differ little from the activities of vocational typists (ATS, pp. 322-324; Erickson, 1971). While personal typists do not type invoices and employed typists do not type poems, the major activities of both kinds of typists are pretty much the same—if not in the same rank order for frequency. All nontrivial typing tasks (those beyond routine, repetitive tasks such as invoicing, form fill-ins, envelope addressing) share the requirement of planning the arrangement of materials on the page, and it is just such activities that comprise the bulk of both personal and vocational typing (aside from the "trivial" tasks of *some* vocational typists).

Thus, the requirements of both kinds of typists can quite easily be met in the same classroom—should school facilities preclude separate instruction. Under either arrangement, national data showing (for the late 1960's through early 1970's) that more than half of all high school graduates undertake at least some college attendance suggests the desirability of rather more attention to manuscripts and reports (i.e., term papers) than has been characteristic—such typing also being more common among vocational typists than has been supposed (Erickson, 1971). Second, whatever the classroom arrangements (separate or combined), there is not the least reason for differences in standards or in the relative attention to stroking skills versus production tasks. The focus belongs on the latter.

Other Objectives and Features of Instructional Materials. The long-established generalization is that intentional is superior to incidental learning—verifying ordinary common sense. The several totally superfluous inquiries into whether typing students can acquire information from the content of the instructional materials (economic concepts, business terminology,[25] or whatever) show that: of course they can, provided the information is made the subject of deliberate class discussion, not left to be picked up incidentally while typing; few typists can and do attend to meaning *while* they copy. To the question: Shall we aim, in the typing classroom, at objectives in addition to typing skill? the answer is: Help yourself, provided direct instruction is given.

The same answer to the same sort of question applies to so-called "integrated" curricula (e.g., typing with language skills, typing with shorthand).[26]

The interest level of typing practice materials is irrelevant. Following prior assessments of students' interest in various topics, practice based on copy at different interest levels had no differential effects on stroking skills (see ATS, p. 317).

Can youngsters of elementary school age learn to type? Certainly, as has been demonstrated numerous times. Physical development is not an

[25] The swamping of vocational by personal typing in this country and the infrequency with which clerical personnel rise to managerial positions should perhaps call for reconsideration of the characteristic focus on business and economic information in much of the materials for typing training in favor of broader topical coverage pertaining to general education.

[26] The various investigations into integrated curricula, like those of intentional vs. incidental learning, are not cited here because they are superfluous demonstrations of the obvious. For access to the particular curricular materials developed for integrated instruction by particular investigators, see the subject indexes of *Dissertation Abstracts* and of *Research in Education*.

important factor in keyboard operation; no differences followed typing instruction to youngsters in grades 3, 5 and 7 who varied in carpal age as measured by x-rays of the hands (De Loach, 1968).

Electric and Manual Typewriters. The data on typewriter sales given earlier make the electric the machine of choice if school finances permit. Indeed, the narrowing cost differential between electric portables and the lower-priced standard manual machines account for the great increase in electric portable sales during the early years of the 1970's (the most recent period as of the preparation of this monograph). So electrics it should be, if possible, with durability a consideration for electric portables.

The instructional, rather than budgetary, question concerns the optimum order of events when training for both machines. There, an established generalization about transfer in tasks that differ in effortfulness, verified in the typing classroom, demonstrates that the optimum order is first manual, then electric, typing—not the reverse (see ATS, pp. 485-486).

Proofreading and Error Counting. Formal investigation (Wong, 1971) verifies what anyone who has taken the trouble to score typescript more than once knows: Many additional errors are found upon a second reading, with a third reading adding just a few more. Thus, in the not infrequent absence of explicit reports by investigators that all student work was scored at least twice (preferably by independent scorers), the typical finding of an average of two errors per minute in straight copy test timings throughout first-year instruction is assuredly an underestimate. So are the error counts of the classroom teacher and for the same reason. True error averages for straight copy typing are perhaps about 2.3 errors per minute.

Similarly verifying ordinary sense and common experience (Staples, 1965): No one proofreads perfectly in one reading of any nontrivial body of typescript; proofreading proficiency is variously correlated with background factors over which the teacher has no control; the negative relationship between proofreading time and proofreading accuracy shows that proofreading must be done word by word, not via the rapid scanning of ordinary silent reading habits.

Finally, no inquiry in the typing classroom is needed to verify a fundamental principle for measurement. Proofreading skill is not part of stroking skill, but an addition to typing requirements. Such tactics as doubly penalizing errors not caught by the student are an absurd offense against measurement principles. Grade for proofreading skill by all means, but separately from stroking skill.

Class Size and Other Scheduling Arrangements. In verification of common observation over the years that typewriting outcomes are little sensitive to differences in class size, scrupulously random assignment of first-year trainees to a class of 26 or to a class of 61 students subjected to identical instruction resulted in no end-of-year differences in stroking skills, production skills, or associated information (Good, 1970).

In recent years "modular scheduling" has been introduced in some schools and has become a topic of inquiry. Organizing instruction into relatively small, self-contained units and basing progress to the next unit of instruction on acceptable performance in the preceding unit is self-evidently desirable, and the merits of so doing require no demonstration. At the same time, what really counts are the internal details of instruction,

and outcomes will vary with variations in those details.[27]

A number of other scheduling practices for typewriting instruction have been investigated. The underlying phenomenon is "distribution of practice," essentially a motivational variable in that fatigue and boredom result from long, continuous work periods without rest. Thus, double periods show only negligible gains over single periods and only for the poorest learners;[28] among advanced college typists, five meetings a week was no better than three (Hansen, 1965).

A Common Difficulty in Acquiring Skill. It is a notorious characteristic of all learned tasks that consist of a series of steps or elements or that require a change in the movements required to execute an element in the series for a slowdown to occur at the point of transition from one element or act to the next. For example, verifying what has been known since the 1920's, there are pauses when using the space bar, before and after punctuation, after using the shift key, and in returning the carriage and indenting for paragraphs (Nellermoe, 1966).[29] Ordinary observation also shows that learners pause between one element and the next in production tasks (e.g., between the date and inside address in a letter, in tabulating from one column to the next in a table). Preaching at students to avoid such delays is, as always, useless. The pertinent and effective tactic, leading to the desired response-response contiguity, is speed forcing across elements or acts A and B when the undesired pause is between A and B. Rush students through the date *plus* the first line of an inside address, through the last line of the message *plus* the complimentary close, from one column entry to the next in a table, and so on.

Another recently verified, long-known fact—but without implications for instruction—is that there is a slowdown before and after stroking errors of the kind the typist is aware of having made (Thompson, 1967).

Motivational Variables. There is virtually nothing about motivation for typewriting that varies in the least from general motivational principles (summarized in ATS, pp. 449-450). Immediate knowledge of results, for example, is the dominating requirement. For typewriting (and in all skills in which high response rates are a criterion of proficiency), racing against the clock toward an individualized goal is a powerful maintainer of motivation. Fatigue is another motivational factor, and it varies according to the effortfulness of the movements involved (the more effort, the more tiring) and their variability (repetition of the same movements being more tiring). Despite traditional suppositions to the contrary, however, typewriting is not an effortful task. For thirty continuous minutes of straight copy typing among 5-108 wpm typists, so administered as to permit measuring performance minute by minute and cumulatively without interrupting the typist, gross speed was unaffected and errors increased only slightly and gradually throughout the work period (ATS, pp. 459-463; or

[27] The references mentioned in Footnote 26 are also applicable here.

[28] The generalizations from the many hundreds of investigations of massed versus distributed practice and the outcomes of a number of schedules for typewriting instruction are described in ATS (pp. 451-455).

[29] Also supporting the generalizations about chaining, different stroking patterns were found at different skill levels, and stable patterns were found only for 2- and 3-stroke words, not for longer words (Nellermoe, 1966).

West, 1969b).[30] Such outcomes by no means suggest that typists should from the start work for long, uninterrupted work periods; for frequent, short rest is a vital condition for efficient learning. The pertinent implication, rather, is that there is not the least reason for devoting weeks and even months on end to very short practice and test timings before reaching, in tests at least, the typical five-minute duration of the straight copy employment test. Besides, measurement principles require that straight copy test length be kept constant throughout training, as explained later in this monograph.

Careful manipulation of anxiety states can also contribute to learning. The general tenor of the psychological research, with which a typewriting study by Ehley (1970) is in accord, suggests that moderate anxiety (i.e., a moderately keyed-up state) is better than either high or low anxiety and that, as between the two extremes, high is preferred to low anxiety. Typical practice procedures for stroking speed necessarily induce the keyed-up state conducive to speed gains; whereas, for accuracy, both the high anxiety resulting from impossibly high accuracy standards and the low anxiety resulting from too generous error allowances (during accuracy practice) should be avoided.

Selection of Trainees. The widespread diffusion of typewriter use in the population demonstrates that basic typing skills are part of general education and should be available to all. Moreover, ordinary copying skills are virtually independent of differences in measured intelligence (ATS, p. 522). More pertinent, early gross stroking speed is an excellent predictor of later gross stroking speed; whereas early stroking accuracy has practically no predictive value for later accuracy (ATS, pp. 212-213).[31] Among Army trainees, for example, those who type less than 6 gross wpm after the first clock hour of instruction (5-minute timings on full-keyboard prose) rarely complete the training successfully (Showell, 1972). For the sake of profitable investment of their educational time and of avoiding emotional damage, such students might well be counseled out of the typing class.

For production skills, the evidence is less clear: relationships with measured intelligence vary with the production tasks and conditions of testing—tending to be of moderate size for realistic tasks done under realistic conditions, but rather low otherwise (ATS, p. 522).[32] In fact, among trainees who have not yet mastered the features unique to production typing (layout of materials on the page), mental ability is uncorrelated with production typing skill (McLean, 1971; West, 1971). More important—and a generalization applicable to all learning, including typewriting—early task performance is a better predictor of later performance than is general intelligence or any other background factor.

[30] As an instance of going overboard on driving students, day after day of four 5-minute, high-pressure practice timings daily had adverse effects on performance (West, 1968d).

[31] Later studies are in total agreement with the findings of the earlier studies given in ATS.

[32] A number of studies, both in earlier years and more recently, that could have contributed useful information on the issue failed to do so because of such absurdities as completely prearranged production tasks and/or no error correction—thereby removing just the features that might be expected to depend on general mental ability.

Role of Stroking Skill in Production Typing Skill

The superstition that stroking skills play a substantial role in production proficiency is one of the major fallacies of traditional instruction. Straight copy stroking errors have near-zero correlations with production stroking errors under conditions of no error correction, and production stroking errors are greatly less than straight copy errors under any and all conditions of production typing (ATS, pp. 327-343). Relationships between straight copy gross speed and production speed vary with variations in production typing training, production test materials, and conditions and stage of training. Among those who have not yet mastered the features unique to production tasks (layout of materials on the page) correlations of straight copy speed with production speed are near zero (McLean, 1971; West, 1971). Among those with higher production skills, the speed correlations are modest to fairly high, varying with the range of straight copy speeds, the difficulty of the production tasks, and the conditions of production testing (viz., on prearranged vs. unarranged copy, with or without error correction)—the artificial (and therefore) nonsense prearranged and/or no error correction condition naturally leading to the higher correlations (Armstrong, 1968; ATS, pp. 329-334; Fischer, 1972; Von Schlick, 1969).[33]

Especially compelling: Straight copy skills do not suffer in the least when they are ignored. With not a single exception, equal or superior straight copy skills were found among those devoting all or most of their training (once past the early weeks) to production skills in comparison to those devoting appreciable time to straight copy skills together with production skills (ATS, pp. 343-347; Carr-Smith, 1973; Reha, 1971; West, 1972).[34] Moreover, as the training progresses and production skills increase, the contribution of stroking skills to production proficiency decreases (Armstrong, 1968; ATS, p. 333); it also decreases, as should be self-evident, with increases in the complexity of the production tasks (ATS, p. 331).

In summary: (1) Straight copy accuracy has near-zero relevance and transfer to stroking accuracy in production tasks. (2) Straight copy speed transfers only moderately to speed at realistic production tasks carried out under realistic conditions. (3) Copying skills do not suffer in the least when ignored (in the earliest of the several studies, starting with Week 6 of the first semester). The implications for instruction are abundantly clear: *(a) During the early weeks devoted to keyboard learning and copying skills, the stress should be on gross speed, not accuracy. (b) Start production training early (Week 6 or shortly thereafter) and give exclusive or nearly*

33 See Armstrong (1968) for a good review of the evidence on the relationships between straight copy and production proficiency in terms of correlations, differences in wpm and error scores, and percentage of transfer.

34 Such outcomes are easily explainable, no matter how superficially surprising they might seem. The acquisition curve for stroking skills is negatively accelerated—gains being made rapidly at the start and more slowly later on. The stroking skills of the student are so modest that any kind of typing (in the present instance, production typing) contributes to gains in stroking skills: large gains at low stroking-skill levels, more modest gains at higher levels.

exclusive attention to it continuously thereafter.[35] The effects on production skills of early and predominant attention to production tasks, as well as the desirable ingredients of production training, are discussed next.

Development of Production Skills[36]

Production proficiency (i.e., skill at the real-life tasks of vocational and personal typing) is *the* objective of instruction. Straight copy skills are germane only to some employment testing and have no other pertinence—no typist copies line for line from perfect print without regard for errors. The very definition of the conditions for maximum positive transfer (from school to life) mandates a close and early match between the content and conditions of instruction and those of later-life typing. The outcomes of various investigations of lesser or greater attention to production skills in relation to stroking skills can be better interpreted after first considering the components of production proficiency.

Components of Production Proficiency. Showell's conclusion for Army typists (1972, p. 55) that "production-copy typing skill is more a function of *experience* with production copy than skill in straight copy typing" is a generalization applicable to any production typist; for the distinctive elements of production typing (primarily, planning the layout of materials on the page and, secondarily, proofreading and error correction) swamp the effects of mere stroking skills in accounting for production proficiency. As a striking demonstration thereof (ATS, p. 341)—under no-erasing conditions, in order to provide an unconfounded assessment of the relative roles of stroking and planning skills—completion time for prearranged production tasks (no planning required of the typist) was 8.9 minutes; for parallel (identical length and characteristics) unarranged tasks (requiring the typist to plan the layout), completion time was 20.9 minutes (with another parallel set of test items, including proofreading and error correction, adding another 3.0 minutes to the work time). In still another study (Webb, as reviewed by Armstrong, 1968), one-fourth to one-third of production typing time was devoted to planning the layout. Such outcomes should make apparent that *making decisions about the arrangement of materials on the page is the heart of production skill. Production typing is overwhelmingly a cognitive, not a manipulative, task.*

It follows, in turn, that mastering the conventions and procedures governing the arrangement of materials on the page (estimating the length of business letters, the space required for footnotes, selecting margins, locating tab stops, et al.) must be the focus of instruction. It should be equally evident that production training and testing that removes the requirement that the typist do his own planning of layout are irrelevant

35 Production training can begin as soon as the learner is no longer struggling over key locations—surely by the time gross speeds of about 20 wpm have been attained. Literally dozens upon dozens of typing researches on numerous topics that happened to report straight copy scores at various stages of training show such speeds to be attained (under test conditions) during the first 4-6 weeks or very shortly thereafter. Under the straight copy training procedures identified as superior earlier in this monograph, such speeds can easily be attained by even the poorest learners within the second month of instruction.

36 See ATS, Chaps. 14 and 15, for details beyond those that can be summarized here.

because u realistic.[37] The central requirement for mastering the cognitive aspects of production typing, described next, is a major empirical finding that pervades all of learning, yet one that seems to be unknown to and violated by the majority of teachers in all school subjects.

Guidance vs. Confirmation Techniques. Guidance refers to explicit advance instructions to the learner before he responds; confirmation, to responding without advance assistance but with the learner's response immediately followed by confirmation or correction by the teacher or other agency. The findings across all of learning are uniform, as follows (ATS, p. 41; or Bugelski, 1956): Guidance is helpful if given in very small amounts confined to the earliest stages of learning any new thing; given in large amounts or past the earliest stages of instruction, it is inferior to confirmation. The shocking violation of the established generalizations about guidance and confirmation is evident in typing textbook business letters regularly accompanied by a word count and a variety of other production tasks endlessly accompanied by explicit advance placement instructions (margins, tab stops, et al.)—violations that largely account for levels of proficiency on realistic typing tasks greatly less than could otherwise be achieved.

The preferable instructional strategy (see ATS, pp. 379-382, for illustrative details) consists, in sequence, of:[38]

1. A *few* guided trials at each new type of task or novel addition to an earlier type of task (i.e., from fully prearranged materials and with step-by-step instructions).

2. Explicit instruction in the conventions and procedures applicable to the layout features of the given task.

3. Deliberate student practice at making placement decisions, often with no actual typing or, at most, with minimal actual typing.[39]

4. Full typing by the student from unarranged materials consisting of very short tasks stripped down to essentials, in which he makes his own placement decisions without advance instructions from teacher or textbook—the students' products being followed by immediate confirmation or correction.

5. Progress to full-scale tasks of varying typical lengths under the same conditions as those given in Step 4.

[37] One cannot conceive of any employer asking his typist to "type this 129-word letter" or to "leave 6 spaces between columns in this table."

[38] The recommended strategy is a straightforward application of the pertinent general principles, and Steps 2-4 in particular were found to lead to immense superiority over traditional instruction (West, 1971 or 1972).

[39] Illustratively: How many words do you estimate this letter, that letter, the other letter to have? What date line location for a letter of 86 words? 172 words? 134 words? How many lines will this footnote, those three footnotes, these two footnotes take? If these are the longest items in a 3-column table (write the 3 items on the blackboard) and 6 spaces are to be left between columns, backspace and tell me where the left margin would be set? And so on—for whatever number of miniature situations may be required until students appear to be able to make correct placement decisions—using tasks stripped down to only the features needed to make those decisions.

RESEARCH FINDINGS ON VARIETIES OF PRODUCTION TRAINING

Several investigations of the effects on production (and on straight copy) proficiency of varying amounts and kinds of attention to production skills in relation to stroking skills have been conducted among high school and college students at various stages of training. Broadly stated, the contrast is between early versus later introduction of production typing or between different proportions of production and stroking practice.[40] All but one of the studies (Reha's, showing no differences in production proficiency following 50-minute periods for production typing versus 15 minutes on stroking skills and 35 minutes on production skills) showed superior production skill to follow from focusing on those skills—at no sacrifice of straight copy skills.[41] From the very large differences in outcomes in the pertinent studies, it should be overwhelmingly apparent that the single greatest improvement in typewriting instruction requires the teacher to:

Begin production training very early with explicit instruction and practice in making placement decisions, followed by student work from unarranged copy requiring him to make his own placement decisions without advance guidance from the teacher or the textbook—but immediately followed by confirmation or correction of students' products. The conventional substantial attention to ordinary stroking skills into relatively late stages of training is totally unjustifiable. As sometimes happens, the pertinent principle is overlooked because it is right under our noses: You learn what you do; to become a proficient production typist, practice at production tasks—not at anything else!

A MISCELLANY OF OTHER PRODUCTION-TYPING CONSIDERATIONS

On the one hand, a number of dominating principles for learning and, on the other, several typewriting investigations contribute additional information about the conduct of production typing training.

Discrimination Training for Alternative Production Procedures. Some employers prefer a "moving" date line in letters (its location varying with letter length); others prefer a "fixed" date line (distance from it to the inside address varying with message length). Simple tables can readily be executed

40 Among them, the details of production training and testing are sometimes explicitly described (Crawford—see ATS, pp. 343-347; Carr-Smith, 1971; West, 1971 or 1972); at other times just how the production training was conducted is not stated (Reha, 1971). Several other studies are not cited here because their production tasks did not require the student to make his own layout decisions.

41 Among advanced college typists in Crawford's study (see ATS, p. 345) "skill" classes did mailable production work at 7.90 wpm, "production" classes at 13.16 wpm. In Carr-Smith's (1973) inquiry (although unfortunately using different teachers for the different methods), in three 30-minute, end-of-course production tests those who started production training in Week 6 completed an average of 8.38 mailable items, traditional students an average of 6.06 mailable items. Among low-ability, first- and second-year high school typists, production training begun in Week 6 and given 100 percent of the time thereafter (following the 5-step "strategy" outlined earlier) led to about half as many layout or placement errors among first-year students (17.7) as were found among second-year students (33.2) subjected to conventional instruction characterized by late introduction of production typing, much "guidance," and substantial concurrent attention to ordinary stroking skills (West, 1971 or 1972)—nearly twice the proficiency in half the training time!

by backspace methods; more complex ones require arithmetic planning or a mixture of arithmetic and spacing methods. In some report styles citations are footnoted; in others (as in this monograph), author and year of publication are given in parentheses within the text. The student who is taught only one of the various alternatives found in the real world is, by definition, short-changed—unprepared for what he may need later on. Without suggesting the impossible—that every conceivable eventuality be covered—certainly the major variations in procedures should be taught.

In that connection, discrimination training analogous to that earlier described for substitution errors is applicable. Firmly rooting one procedure by long-term focus on it before introducing the alternative is a mistake because it is difficult to dislodge established habits. The more effective strategy is to pair the alternative procedures: sometimes side by side, at other times introducing Alternative B after moderate facility has been established at Alternative A. The former is instanced by date line placement in letters; the latter, by backspacing vs. arithmetic for tables.[42]

Practice Goals. Speed is one of the criteria of proficiency, and the requirement for its development differs in no wise from the basis for building ordinary stroking speed: racing against the clock or, more generally, routinely informing all students of their work speeds throughout production practice.[43] A master's thesis by Shephardson, reviewed by Armstrong (1968), merely verifies the obvious: that superior outcomes follow timed, in contrast to untimed, production work. Armstrong's own inquiry into various types of production goals resulted in mixed outcomes, but with the setting of minimum-output goals found to be anxiety-producing—illustrating the risks of imposing such standards in the absence of normative data and the clear superiority of the tactics described in Footnote 43.

Varieties of Production Tasks. Wise (1968) is among several who have attempted to determine the relative frequency of various kinds of production tasks among employed typists (see ATS, pp. 323-324; Erickson, 1971, for others). The findings of the various studies disagree in smaller details because of gross differences in sampling procedures and sample size, but all agree on the widespread engagement of typists in correspondence, tables, and reports, with correspondence clearly in the lead. Training time, however, is not a function of task frequency but of task difficulty. Tables, for example, need practice out of proportion to their frequency relative to correspondence in the work of employed (and personal) typists because they tend to be more difficult. The prevalence of longhand and mixed-type-and-longhand raw materials in the work of employed typists is especially to be noted.

42 Simple distinctions can be paired; more complex ones need at least some spacing in time. Above all, avoid long delay in introducing the alternative procedure and never fail to conduct explicit discrimination training. E.g.: Letter of 118 words. What location for a moving date line? with a fixed dateline? how many lines down to the inside address?

43 The process is simplicity itself and, during practice activities, is quite informal, the measure being completion time, wholly bypassing the needless arithmetic of wpm scoring. All start together by stopwatch; each student upon completing the task raises his hand and is informed by the teacher of the elapsed time (usually, to the nearest 1/4-minute). The speed goals are not absolute ones—for no one has the slightest idea how long it "should" take to complete a given task. Instead, the student assesses his completion time relative to that of others and to his previous performance on tasks of comparable length and characteristics.

The really crucial requirement is this: *The raw materials from which the student works should faithfully match the characteristics of real-world vocational and personal typing raw materials*—free, insofar as the economics of textbook publishing permit, of the perfect print and the other artificialities of traditional practice and test materials. The foregoing caveat applies particularly to excessive guidance (word counts, margin and tab stop information accompanying the task—whether in the text or from the teacher).

Distribution of Practice at Various Production Tasks. Should one devote a substantial block of time to a given type of task (say, business letters) and then similarly long blocks to other topics in turn (say, tables, reports, business forms); or is it better to rotate cyclically over shorter time periods to each type of task? The possible arrangements are to all practical purposes infinite (change within days, by days, by weeks, by months).[44] One 64-day inquiry (Hamed, 1968) contrasted 16-day blocks to each of four types of tasks in turn with four cycles of 4-day blocks, with outcomes that were not consistent. The dominant generalization across the entire psychology of learning is, of course, that distributed is better than massed practice, especially in skills. Probably, the time given to a class of task should not be so long that boredom is induced (or forgetting of procedures applicable to previously practiced other types of tasks); equally probably, flitting from one type of task to the next early in learning could lead to confusion. Probably, some massing of the earliest practice at each new type of task is desirable, with substantial distribution thereafter (see ATS, pp. 395-396).

Performance Standards and Proficiency Testing[45]

The establishment of standards and the measurement of human performance are rather more technical matters than most teachers imagine, and the slighting of such matters in most teacher-education programs probably accounts for testing being among the weakest aspects of educational practices everywhere. The present discussion is confined to highpoints, mostly resting on the fundamental measurement concepts of validity and reliability, plus findings particular to typewriting.

PERFORMANCE STANDARDS

For straight copy typewriting, terminal achievement falls within a remarkably narrow range in numerous studies covering thousands of students across the nation and over the years.[46] The reported averages rarely differ by more than 2-3 wpm from one study to another. Two large-scale studies are sufficiently representative of all of them. On a 5-minute timing of

[44] See ATS, pp. 241-242, for illustrations of possibilities in the context of speed and accuracy practice that are equally applicable, in theory, to production-task practice.

[45] For details on performance standards, see ATS, Chap. 20. Basic principles for testing and procedures for straight copy and for production testing are treated in depth and detail in Chaps. 21-23, respectively. Another comprehensive but less detailed treatment is also available (West, 1975).

[46] Such outcomes do not say much for what has been done to develop stroking skills over the years—probably because of the stubborn persistence of superstitious notions about stroking accuracy and the failure to individualize and properly distribute stroking-skills practice.

unspecified difficulty (but probably at a syllabic intensity of about 1.40), Balsley (see ATS, p. 499) reported the mean (average) gross speeds at the end of high school semesters 1-4 to be, respectively, 32, 40, 46, and 50 wpm. Robinson (see ATS, p. 501), using copy at a syllabic intensity of 1.50, reported means at the end of Semesters 1 and 2 of 28 and 38 gross wpm.

Dozens upon dozens of studies report an average of 10 errors in 5 minutes throughout first-year high school instruction (Weeks 6-36)—all too often, unfortunately, based on the better of two trials and on one proofreading of the typescript for errors.

Production typing is characterized by the total absence of any standards that have discernible reliability or widespread acceptability. From the championship typewriting contests dating back to the early years of this century until today, straight copy skills have been the be-all and end-all of proficiency measurement; for the production skills that are the real objectives of instruction, there are no standards. Of course, a precondition for standards is sufficiently precise characterization of the tasks for which standards are sought, mainly their difficulty levels. Wise (1968) and McLean (1971) have made beginnings, but a great deal more needs to be done, and acceptable standards require a base of very large numbers of students and/or entry employees and very fussy sampling procedures.

STRAIGHT COPY TESTING

The recommendations given here are inescapable inferences from the fundamental requirements for valid and reliable measurement of anything[47] and from findings particular to typewriting. Because straight copy proficiency has so little bearing on the production skills that are the real objectives of instruction, the more detailed whys and wherefores of desirable procedures for straight copy testing are not worth expressing here; for them, see the references cited in Footnote 45. Here, only some major concepts and findings are given as a basis for recommendations.

1. The attribution of changes in scores over time only to changes in skill requires that test length, conditions of administration, and difficulty be constant. Otherwise, ambiguity results.

a. Because employment testing is nearly always for 5 minutes, *all test timings after keyboard presentation should be for 5 minutes, neither more nor less.* The traditional snail's pace approach to 5-minute test durations has no justification and is predicated on assumptions about typing fatigue that are pure myth.[48]

b. *Constancy of test administration conditions applies particularly to test instructions.* Advice to reduce errors on one occasion but to add to speed on another seriously reduces the reliability of the resulting measures. The proper instruction at all times is: Type at a comfortable rate; neither

[47] A valid test measures (ideally) all of and nothing but *what* it ought to measure, and a reliable test supplies a sufficiently *accurate* measure of each person's *typical* performance (Thorndike and Hagen, 1969, Chap. 6). A reliable measure is reasonably stable; an unreliable one hops around from one occasion to another.

[48] This is not to say that speeds are the same over all test durations, but rather that a change in score between a 1-minute test in September and a 5-minute test in December is *not* an unconfounded measure of change in skill.

try to set a new record for speed nor slow down to an unnatural crawl in the hope of avoiding all errors.

c. Test difficulty varies with the characteristics of the copy. Differences in those characteristics affect only gross speed (not errors, despite what some have claimed) and, even then, only among those beyond about 25 gross wpm speeds (ATS, p. 532; McInturff, 1964, among others). The beginner is unaffected because he types letter by letter no matter what the words.[49] Among three commonly used difficulty indices, "percentage of common words," for various technical reasons, is not a very useful index. The better indices are stroke intensity (average number of typewriter strokes per dictionary word, including spacing and punctuation) and syllabic intensity (average number of *speech* syllables per dictionary word). For the vocabulary of written business communication, the true mean values are 1.54 and 6.0 for syllabic and stroke intensity respectively, and 1.51-1.57 or 5.7-6.3 are within the average range (ATS, pp. 534-535; or West 1968b or 1968c).[50] If straight copy scores from one occasion to the next are to represent true measures of change in skill toward the requirements of later-life typing, the materials for *all straight test copy timings after keyboard presentation should center closely around a syllabic intensity of 1.54 or a stroke intensity of 6.0.*

2. The interest is in typical, not unique, performances. Allowing a choice between the better or best of several trials may be philanthropic or therapeutic, but it makes a travesty of what measurement is all about. *Never permit a choice among performances; always average the speeds and average or sum the errors across all test timings on any given testing occasion.*[51]

3. Because speed scores are highly reliable but error scores notoriously unstable (ATS, p. 296)—

a. *Always score separately for speed and errors; never use composite scores, such a net wpm and others.*[52] They have lesser reliability than separate scores and they are uninterpretable because any composite score can represent innumerable combinations of speed and errors.

b. *Give more weight to gross speed than to errors*—not only because of their greatly differing reliabilities, but also because only straight copy speed, not errors, is correlated with production proficiency.

c. Even barely acceptable reliability for measures of errors requires at least a 10-minute sample of performance (a pair of 5-minute timings).

[49] For beginners, the fussy grading of materials at progressively increasing difficulty levels is a monument to effort without useful purpose or effect. Even among 50-75 wpm typists, large differences in syllabic intensity had trivially small effects on percentage of accuracy, centering around 1 percent (Diehl, 1972).

[50] The consequence of the faulty traditional assumptions of 1.40 as mean syllabic intensity and 5.0 as mean stroke intensity is to overestimate stroking speed by about 1-4 wpm, varying with the typist's skill level, and to underprepare him for the vocabulary of real-life typing. In substantiation thereof, some modest evidence (Wise, 1968) shows that the typing textbook vocabulary is too simple in relation to the vocabulary of on-the-job materials.

[51] Error-cutoff scoring, which ignores all work past a certain number of errors, is particularly offensive (West and McLean, 1968).

[52] See ATS, pp. 539-556, *passim*, for the mechanics of separate scoring and for assigning a grade to total performance; or see West (1975).

Assessing errors from just one brief timing is useless.

4. Finally, correcting of errors during straight copy timings is totally uncalled for and represents a complete misconception of the purposes and values of straight copy practice and testing. For one thing, erasing will destroy the predictive value of straight copy gross speed for production speed; for another, there is no sensible (reliable) way to score for errors the typist does not notice. Under ordinary conditions typists notice 55-75 percent of their errors *while typing* (ATS, p. 82).

PRODUCTION TESTING

Nearly everything that can be said about production testing is governed by the requirements for valid and reliable measurement. Little is particular or unique to typewriting. The summary principle for valid production testing is:

> *Omit from test content and conditions nothing that is relevant and admit nothing that is irrelevant to real-life typewriting activities.*

Test Content and Conditions. The major features illustrating the foregoing principle are:

1. The use of unarranged, not prearranged, test materials and the total absence of advance information on placement or layout of materials on the page (number of words, margins, tab stops). Test materials that permit exact copying measure nothing of any consequence, and the later-life requirement for all typists is that they make their own placement decisions, without advance guidance.

   a. Raw materials in longhand or mixed type and longhand are very common in the work of employed and personal typists; so such materials should be lavishly present in school tests.

2. The varieties of real-world practices should be represented in the testing: business letters in various styles and of various lengths, tables that can be done by spacing methods and those that require arithmetic planning, for example. Other features can be captured on a sampling basis; e.g., "Make a carbon copy of Letter 1 and address a small envelope for Letter 2 and a large one for Letter 3."

3. Production testing (and practice) that omits proofreading and error correction is a very serious offense against validity.[53]

Test Scoring. The governing principle is:

> *Both speed and quality of work are the criteria of typewriting proficiency, so both should always be measured—separately, never expressed as a single composite score.*

The sequential steps in scoring production tests consist of (a) determining speed of work, (b) assigning a grade to work speed, (c) assigning a grade to the quality of the work, and (d) combining the separate speed and quality grades into an overall grade.[54]

[53] During production practice or training, there is no point to error correction while the student is learning the rudiments of the task; but it should be introduced immediately thereafter. Deferring error correction until late stages of training is indefensible.

[54] Detailed explanation and illustration are given in ATS (pp. 577-589), with lesser detail in West (1975). Here, the highpoints are briefly described.

1. The measurement of speed of work starts after the distribution of test materials and the giving of general test instructions and concludes with completion of the work, including all handling of materials and planning of layout before and during the typing.

a. Because incomplete work cannot be scored for quality (it is impossible to know what errors would have been made had the work been completed), it is important to permit all or nearly all students to complete the work and to measure speed as completion time to the nearest 1/4-minute or, sometimes, 1/2-minute, *not* words per minute.[55] Grades can as easily be assigned to time scores as to work scores—and by the same process.[56]

b. Under completion-time speed scoring, students finish at different times. The faster students may be kept busy in any sensible way—but not by the invalid and unreliable procedure of including so-called bonus work in the test.

2. Grades for various completion times are assigned on a relative basis because no one knows how long a given production task "should" take. No such problem exists for assessing quality of work. During the earlier stages of production training and testing, quality of work can properly employ a penalty system involving deductions (from 100 points for perfect work) of penalties of various sizes for errors of different degrees of seriousness. Errors that variously affect mailability, according to the judgments of employers, have been identified (ATS, pp. 580-581) and provide an excellent basis for a penalty system. Later on, the essentially go/no go standards of the world of work should prevail (mailable, mailable with corrections that can feasibly be made without complete retyping, unmailable). At such stages a quality grade would be based on the number or percentage of total items attempted that are mailable, with fractional credit for those that need and readily permit corrections and no credit for unmailable items.

a. With such exceptions as ordinary good sense may dictate, the real-life situation of as many trials at an item as the student may wish should prevail. Speed is total time across all trials, whereas quality is assessed only on the final version the student submits—all earlier, aborted attempts at the item being discarded. Students quickly learn that time does not permit endless starting over again and soon act sensibly in that regard.

3. Composite scores (mailable wpm, net production wpm, and the like) are just as objectionable for production typing as are their analogs for straight copy typing (net or correct wpm), and for the same reason. Any such score can represent innumerable combinations of speed and quality (thus measuring neither the one nor the other in any clear fashion), and two students (one fast and inaccurate, the other slow but accurate) could earn the same net (or other composite) score. The same score assigned to persons

[55] "Work" scores are appropriate to essentially repetitive tasks in which each item is pretty much like any other. Examples are: number of envelopes or invoices or premium notices (and other such tasks) per unit of time (1/2-hour, hour, day). With the possible exception of business letters, wpm is a meaningless measure of production skill because speed depends far more on the complexity of the task than on the number of words in it.

[56] See Footnote 43 for completion-time procedures and—for assigning grades to completion times—the references cited in Footnote 54.

of very different skills is a flagrant violation of fundamental measurement principles.

4. The final step is to combine the separate speed and quality grades into an overall grade, giving either equal weight to the two or more weight to quality.[57]

5. The proportion of the total score assigned to each item in a test battery consisting of several different types of items should of course reflect the length, difficulty, and importance of the item (see ATS, pp. 589-592, for illustrative details). Also, the penalties for errors should be in proportion to the item weights: a major error costing, say, 10 points in an item given much weight should cost fewer points in an item given less weight.

The various production scoring procedures outlined here require more painstaking attention to detail and a little more scoring arithmetic by the teacher than conventional scoring processes, but the difficulties disappear as experience with such scoring accrues, and the gain is testing that results in accurate assessment of true production skills.

Afterword

In relation to the many aspects of typewriting instruction covered in this monograph, the most important recommendations—the ones that can lead to substantial improvement in outcomes—are:

1. Early (Week 6 or closely thereabouts) attention to production skills, with only occasional attention to ordinary stroking skills thereafter.

2. Realistic production tasks typed under realistic conditions (immediately following early and explicit teaching of and practice at placement or layout processes) and the replacement of endless guidance by confirmation procedures.

3. Total discarding of the utter fiction that stroking accuracy benefits from practice at specialized drills built around various stroking sequences. For building ordinary stroking skills the major focus belongs on gross speed, and accuracy depends on typing at the right speed.

4. Complete individualization of speed and accuracy practice for building stroking skills.

5. Valid and reliable measurement of typewriting proficiency.

[57] Giving equal weight to an S (speed) grade of 86 and a Q (quality) grade of 70 would result in an overall grade of $(86 + 70) \div 2 = 78$. Giving quality twice the weight of speed would result in $[2(70) + 1(86)] \div 3 = 226/3 = 75.3 = 75$. (The conversion of numerical into letter grades is described in ATS, pp. 592-594.)

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Notes. (1) References to doctoral dissertation include mention of the pertinent *Dissertation Abstracts* listing (Volume A). For example: [DA 1969(29), p. 4363] means that page 4363 in Volume 29, published in 1969, contains the abstract of the study. (2) References to funded studies are accompanied by the ERIC ED No. in *Research in Education* containing the abstract. (3) Publications by the same author in the same year are lettered serially; e.g., 1968a, 1968b, etc.

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